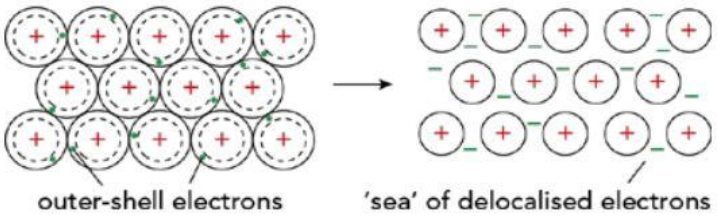
3.3 METALLIC BONDING

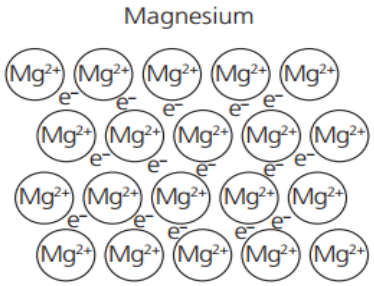
Learning outcomes
Candidates should be able to:
define metallic bonding and draw an illustration

What is a metallic bond?

GCSE Chemistry - Metallic Bonding #20 (youtube.com)

In a metal, the atoms are packed closely together in a regular arrangement called a **lattice**. Metal atoms in a lattice tend to lose their outer shell electrons and become positive ions. The outer shell electrons occupy new energy levels and are free to move throughout the metal lattice. We call these electrons **delocalized electrons** (mobile electrons). Delocalised electrons are electrons that are not associated with any one particular atom or bond.
Metallic bonding is strong. This is because the ions are held together by the strong electrostatic attraction between their positive charges and the negative charges of the delocalised electrons.





1. "Electrostatic attraction between cations and delocalized electrons."
   Which of the following bonds does the statement best describe?

   a. Hydrogen
   b. Dipole
   c. ionic
   d. metallic

1. $LiAlH_4$ decomposes slowly to form LiAl(s) and $H_2(g)$.
   $LiAlH_4(s) \rightarrow LiAl(s) + 2H_2(g)$
   LiAl(s) shows metallic bonding. Describe metallic bonding. [1]

This electrostatic attraction acts in all directions. The strength of metallic bonding increases with:

- increasing positive charge on the ions in the metal lattice
- decreasing size of metal ions in the lattice
- increasing number of mobile electrons per atom.

Most metals have high melting points and high boiling points
It takes a lot of energy to weaken the strong attractive forces between the metal ions and the delocalized electrons. These attractive forces can only be overcome at high temperatures.

Metals conduct electricity

When a voltage is applied to a piece of metal, an electric current flows in it because the delocalized electrons (mobile electrons) are free to move. Metallic bonding is the only type of bonding that allows us to predict reliably that a solid will conduct electricity. Covalent solids cannot conduct electricity because none of their electrons are free to move throughout the structure, although graphite is an exception to this. Ionic solids cannot conduct because neither their electrons nor their ions are free to move from place to place.

Metals conduct heat

The conduction of heat is partly due to the movement of the delocalised electrons but mainly due to the vibrations passed on from one metal ion to the next.

2. Draw a labelled diagram to show the structure and bonding in sodium. [1]

3. Magnesium shows reactions typical of a Group 2 metal.
   Draw a labelled diagram to show the bonding in magnesium metal. [2]

4. Bismuth is a dense metal in the same group as phosphorus.
   Draw a labelled diagram to show the bonding in bismuth metal. [2]
5. Bismuth is an element in Group 15 of the Periodic Table.
   Bismuth has metallic bonding.
6. Draw a labelled diagram to show the metallic bonding in bismuth. [1]
7. The Group 2 elements Mg to Ba are all silvery-white reactive metals.
   (i) Draw a labelled diagram to show the bonding and structure of the Group 2 metals at room temperature.[2]
   (ii) Explain why Mg has a higher electrical conductivity than Na. [1]

1. Copper has a high melting point.
   What is the reason for the high melting point of copper?

   A strong attractive forces between copper atoms only
   B strong attractive forces between copper ions and delocalised electrons
   C strong attractive forces between copper ions only
   D strong attractive forces between copper atoms and delocalised electrons

2. Which statement explains why calcium has a higher melting point than barium?

   A Calcium cations are smaller than barium cations and have a stronger attraction to the delocalised electrons.
   B The structure of calcium is partly giant molecular.
   C There are more delocalised electrons in calcium than in barium as it has a lower ionisation energy.
   D There is greater repulsion between barium atoms as they have more complete electron shells than calcium atoms.

3. Which statement explains why sodium and potassium have different melting points?

   A The attraction between cations and delocalised electrons is stronger in sodium.
   B The attraction between cations and anions is stronger in sodium.
   C The attraction between atoms is stronger in sodium.
   D The attraction between nuclei and shared electron pairs is stronger in sodium.

*****This is not a complete note. It is to guide you. It is recommended to study the prescribed textbooks along with this material. *****